

WHAT IS CLAIMED IS:

1. A waveform equalization apparatus comprising:

a first input terminal to which only a real component of a digital input signal to be waveform-equalized is applied;

a second input terminal to which only an imaginary component of the digital input signal to be waveform-equalized is applied;

plural transversal filters for performing filtering processes for waveform equalization on the digital input signal;

a first output terminal from which only a real component of a waveform-equalized digital output signal is outputted;

a second output terminal from which only an imaginary component of the waveform-equalized digital output signal is outputted;

plural selectors for selecting a connection of lines which interconnect the first or second input terminal, the plural transversal filters, and the first or second output terminal; and

a filter construction control signal generator for generating a filter construction control signal which controls the plural selectors to control the filter construction such that the whole apparatus becomes a real component filter when the digital input signal is a signal having only a real component, and becomes a complex filter when the digital input signal is a signal having both a real component and an imaginary component.

2. The waveform equalization apparatus of Claim 1, wherein the

same number of transversal filters among the plural transversal filters are used when the whole apparatus becomes a real component filter as well as when the whole apparatus becomes a complex filter.

3. The waveform equalization apparatus of Claim 1, wherein the signal having only the real component is a VSB signal, and the signal having both of the real component and the imaginary component is a QAM signal.

4. The waveform equalization apparatus of Claim 1, wherein a predetermined transversal filter among the plural transversal filters has plural taps; and

the waveform equalization apparatus further comprising:

a tap selector for selecting one of the plural taps; and

a center tap control signal generator for generating a center tap control signal for changing the position of a center tap of the predetermined transversal filter, by controlling the tap selector.

5. The waveform equalization apparatus of Claim 1, wherein the tap length of a predetermined transversal filter among the plural transversal filters is changeable according to a filter operation control signal; and

the waveform equalization apparatus further comprising a

filter operation control signal generator for generating a filter operation control signal which changes the filter operation by changing the tap length of the predetermined transversal filter.

6. A waveform equalization apparatus comprising a first input terminal to which a digital input signal having only a real component is inputted; a second input terminal to which a digital input signal having only an imaginary component is inputted; first and second output terminals; first to fourth transversal filter (hereinafter referred to as TF) units for performing filtering processes for waveform equalization; a delay means for delaying an input signal to output a delayed signal; and first and second tap coefficient control means for controlling tap coefficients of the first to fourth TF units, wherein

when a signal is applied to only the first input terminal, the first to fourth TF units are connected as follows:

the signal applied to the first input terminal is inputted to the first TF unit; a signal which is obtained by delaying a signal outputted from the first output terminal with the delay means is inputted to the second TF unit; a delay output from the second TF unit is inputted to the third TF unit; a delay output from the third TF unit is inputted to the fourth TF unit; and signals which are filter-processed by the second to fourth TF units are added to a signal which is filter-processed by the first TF unit and a main signal component of the first TF unit,

and the result of the addition is outputted from the first output terminal; and

waveform equalization is performed on the input signal to the first input terminal while controlling the tap coefficients of the first to fourth TF units with the first tap coefficient control means on the basis of the output from the first output terminal, and a signal so obtained is outputted from the first output terminal; and

when signals are applied to both of the first input terminal and the second input terminal, the first to fourth TF units are connected as follows:

the signal applied to the first input terminal is inputted to the first and third TF units; the signal applied to the second input terminal is inputted to the second and fourth TF units; the main signal component of the first TF unit is added to a value which is obtained by subtracting the signal filter-processed by the second TF unit from the signal filter-processed by the first TF unit, and the result of the addition is outputted from the first data output terminal; and the signal filter-processed by the third TF unit, the signal filter-processed by the fourth TF unit, and the main signal component of the fourth TF unit are added, and the result of the addition is outputted from the second output terminal; and

the input signals applied to the first and second input terminals are subjected to waveform equalization while

controlling the tap coefficients of the first to fourth TF units with the second tap coefficient control means on the basis of the outputs from the first and second output terminals, and the real component of the signal so obtained is outputted from the first output terminal while the imaginary component of the signal so obtained is outputted from the second output terminal.

7. The waveform equalization apparatus of Claim 6, wherein

each of the first and fourth TF units is provided with n pieces of TFs (n : integer equal to or larger than 3), and the respective TFs are connected such that a delay output from the m -th TF ($1 \leq m \leq n-1$, m : integer) is inputted to the $(m+1)$ th TF, and

said waveform equalization apparatus further including:

a first selection means for receiving delay outputs from the first to $(n-1)$ th TFs of the first TF unit, respectively, selecting one of the plural delay outputs on the basis of a center tap control signal that is supplied from the outside, and outputting the selected signal as a main signal component of the first TF unit; and

a second selection means for receiving delay outputs from the first to $(n-1)$ th TFs of the fourth TF unit, respectively, selecting one of the plural delay outputs on the basis of the center tap control signal, and outputting the selected delay output as a main signal component of the fourth TF unit.

8. The waveform equalization apparatus of Claim 6, wherein
 at least one of the first to fourth TF units is provided with
 n pieces of TFs (n : integer equal to or larger than 2), and the
 respective TFs are connected such that a delay output from the m -
 th TF ($1 \leq m \leq n-1$, m : integer) is inputted to the $(m+1)$ th TF, and
 the operating state of at least one of the TFs is switched
 between the active state and the halt state by a filter operation
 control signal that is supplied from the outside.

The waveform equalization apparatus of Claim 6, wherein
 each of the first and fourth TF units is provided with n
 pieces of TFs (n : integer equal to or larger than 2), and the
 respective TFs are connected such that a delay output from the m -
 th TF ($1 \leq m \leq n-1$, m : integer) is inputted to the $(m+1)$ th TF;
 each of the second and third TF units is provided with s
 pieces of TFs (s : integer equal to or larger than 2), and the
 respective TFs are connected such that a delay output from the t -
 th TF ($1 \leq t \leq s-1$, t : integer) is inputted to the $(t+1)$ th TF; and
 the operating state of at least one TF among the plural TFs
 constituting each of the first to fourth TF units is switched
 between the active state and the halt state by a filter operation
 control signal that is supplied from the outside.

10. A waveform equalization apparatus comprising:
 a first input terminal to which a digital input signal having

only a real component is applied;

a second input terminal to which a digital input signal having only an imaginary component is applied;

a first TF unit for receiving the input signal applied to the first input terminal, and outputting a signal which is subjected to a filtering process for waveform equalization, and a main signal component in the filtering process;

a first selection circuit having first and second inputs, receiving, as the second input, the input signal applied to the second input terminal, and selecting either of the first and second inputs to output the selected input;

a second TF unit for receiving the output of the first selection circuit, and outputting a signal which is subjected to a filtering process for waveform equalization, and a delay signal obtained by delaying the input signal;

a second selector for selecting either the input signal applied to the first input terminal or the delay signal outputted from the second TF unit, and outputting the selected signal;

a third TF unit for receiving the output of the second selection circuit, and outputting a signal which is subjected to a filtering process for waveform equalization, and a delay signal obtained by delaying the input signal;

a third selector for selecting either the input signal applied to the second input terminal or the delay signal outputted from the third TF unit, and outputting the selected

signal;

a fourth TF unit for receiving the output of the third selection circuit, and outputting a signal which is subjected to a filtering process for waveform equalization, and a main signal component in the filtering process;

a fourth selector for selecting either the signal obtained by the filtering process in the second TF unit or a signal obtained by inverting the filter-processed signal, and outputting the selected signal;

a fifth selector for selecting either a signal which is obtained by adding the output of the fourth selector and the signal obtained by the filtering process in the first TF unit, or the main signal component outputted from the fourth TF unit, and outputting the selected signal;

a sixth selector for selecting either a signal which is obtained by adding the output of the fourth selector and the signal obtained by the filtering process in the first TF unit, or a signal which is obtained by adding the signal obtained by the filtering process in the third TF unit and the signal obtained by the filtering process in the fourth TF unit, and outputting the selected signal;

a first output terminal for outputting a signal which is obtained by adding the output of the sixth selector and the main signal component of the first TF unit;

a delay unit for delaying a signal which is obtained by

adding the output of the sixth selector and the main signal component of the first TF unit, and outputting the delayed signal so that it becomes a first input to the first selector;

a second output terminal for outputting a signal which is obtained by adding the output of the fifth selector, the signal obtained by the filtering process in the third TF unit, and the signal obtained by the filtering process in the fourth TF unit;

a first tap coefficient control means for controlling the tap coefficients of the first to fourth TF units, on the basis of a signal which is obtained by adding the output of the sixth selector and the main signal component of the first TF unit; and

a second tap coefficient control means for controlling the tap coefficients of the first to fourth TF units, on the basis of the signal which is obtained by adding the output of the sixth selector and the main signal component of the first TF unit, as well as the signal which is obtained by adding the output of the fifth selector, the signal obtained by the filtering process in the third TF unit, and the signal obtained by the filtering process in the fourth TF unit;

wherein, when a signal is inputted to only the first input terminal, the first selector selects the input from the delay unit and outputs it; the second selector selects the delay signal from the second TF unit and outputs it; the third selector selects the delay signal from the third TF unit and outputs it; the fourth selector selects the signal which is obtained by the

filtering process in the second TF unit, and outputs it; the fifth selector selects the signal which is obtained by adding the output of the fourth selector and the signal obtained by the filtering process in the first TF unit, and outputs it; the sixth selector selects the signal which is obtained by adding the output of the fifth selector, the signal obtained by the filtering process in the third TF unit, and the signal obtained by the filtering process in the fourth TF unit, and outputs it; and the first tap coefficient control means controls the tap coefficients of the first to fourth TF units; and

when signals are inputted to both of the first input terminal and the second input terminal, the first selector selects the input of the second input terminal and outputs it; the second selector selects the input of the first input terminal and outputs it; the third selector selects the input of the second input terminal and outputs it; the fourth selector selects an inverted signal of the signal which is obtained by the filtering process in the second TF unit, and outputs it; the fifth selector selects the main signal component of the fourth TF unit and outputs it; the sixth selector selects the signal which is obtained by adding the output of the fourth selector and the signal obtained by the filtering process in the first TF unit, and outputs it; and the first tap coefficient control means controls the tap coefficients of the first to fourth TF units.

11. The waveform equalization apparatus of Claim 10, wherein each of the first and fourth TF units is provided with n pieces of TFs (n : integer equal to or larger than 3), and the respective TFs are connected such that a delay output from the m -th TF ($1 \leq m \leq n-1$, m : integer) is inputted to the $(m+1)$ th TF, and a signal which is obtained by adding the signals that are filter-processed by the respective TFs is outputted as a filter-processed output from each of the first and fourth TF units;

said waveform equalization apparatus further including:

a seventh selection means for receiving delay outputs from the first to $(n-1)$ th TFs of the first TF unit, respectively, selecting one of the plural delay outputs on the basis of a center tap control signal that is supplied from the outside, and outputting the selected signal as a main signal component of the first TF unit; and

an eighth selection means for receiving delay outputs from the first to $(n-1)$ th TFs of the fourth TF unit, respectively, selecting one of the plural delay outputs on the basis of the center tap control signal, and outputting the selected signal as a main signal component of the fourth TF unit.

12. The waveform equalization apparatus of Claim 10, wherein

at least one of the first to fourth TF units is provided with n pieces of TFs (n : integer equal to or larger than 2), and the respective TFs are connected such that a delay output from the m -

th TF ($1 \leq m \leq n-1$, m : integer) is inputted to the $(m+1)$ th TF, and the operating state of at least one of the TFs is switched between the active state and the halt state by a filter operation control signal that is supplied from the outside.

13. The waveform equalization apparatus of Claim 10, wherein

each of the first and fourth TF units is provided with n pieces of TFs (n : integer equal to or larger than 2), and the respective TFs are connected such that a delay output from the m -th TF ($1 \leq m \leq n-1$, m : integer) is inputted to the $(m+1)$ th TF;

each of the second and third TF units is provided with s pieces of TFs (s : integer equal to or larger than 2), and the respective TFs are connected such that a delay output from the t -th TF ($1 \leq t \leq s-1$, t : integer) is inputted to the $(t+1)$ th TF; and

the operating state of at least one TF among the plural TFs constituting each of the first to fourth TF units is switched between the active state and the halt state by a filter operation control signal that is supplied from the outside.

14. A waveform equalization apparatus comprising:

an input terminal to which a digital input signal having only a real component is applied;

a first TF for performing a waveform equalization filtering process on the input signal applied to the input terminal;

an adder for receiving, as one of plural inputs, the filter-

processed output from the first TF, and adding the inputted signals to output the result of the addition;

an output terminal for outputting the output of the adder;

a delay unit for delaying the output of the adder, and outputting the delayed signal;

a slicer for slicing the output of the delay unit;

a second TF for performing a waveform equalization filtering process on the output of the slicer, inputting the filter-processed signal to the adder, and outputting a delay output obtained by delaying the output of the slicer, and signals obtained from the respective taps;

a third TF for performing a waveform equalization filtering process on the delay output of the second TF, inputting the filter-processed signal to the adder, and outputting a delay output obtained by delaying the delay output of the second TF, and signals obtained from the respective taps;

a fourth TF for performing a waveform equalization filtering process on the delay output of the third TF, inputting the filter-processed signal to the adder, and outputting signals obtained from the respective taps; and

a tap coefficient control means for controlling the tap coefficients of the first to fourth TFs on the basis of the output of the adder, and the signals obtained from the respective taps of the second to fourth TFs.

15. A waveform equalization apparatus comprising:

an input terminal to which a digital signal is applied;

a test signal generator for generating a signal for test;

an input signal selection means for selecting either the signal applied to the input terminal or the test signal, on the basis of a mode input signal that is supplied from the outside;

a digital filter unit having at least one TF, and performing a filtering process for waveform equalization on the signal that is selected by the input signal selection means;

an output terminal for outputting the signal that is filter-processed by the digital filter unit; and

a tap coefficient control means for updating the tap coefficient of the TF in the digital filter unit on the basis of the signal that is filter-processed by the digital filter unit when the input signal selection means selects the signal applied to the input signal, and performing no updation of the tap coefficient when the input signal selection means selects the test signal.